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Discovery

Design of greenhouse control system based on wireless sensor networks using MATLAB

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ABSTRACT

In order to accurately determine the growth of greenhouse crops, the system based on Single Chip 8051microcontroller and wireless sensor networks is developed, it transfers data through the wireless transceiver devices without setting up electric wiring, the system structure is simple. The monitoring and management center can control the temperature and light intensity of the greenhouse, measure the water content, and collect the information about intensity of illumination, and so on. The system has advantages of low power consumption, low cost, good robustness, extended flexible. An effective tool is provided for monitoring using MATLAB and analysis decision-making of the greenhouse environment.

Keywords: Greenhouse Introduction, System structure for WSN, MATLAB, AT89c51μc

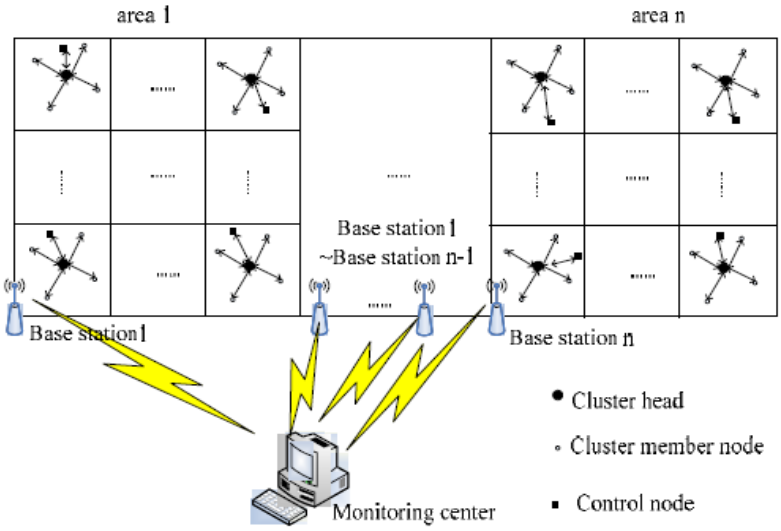
1. INTRODUCTION

Greenhouse is a kind of place which can change plant growth environment, create the best conditions for plant growth, and avoid influence on plant growth due to outside changing seasons and severe weather. For greenhouse measurement and control system, in order to increase crop yield, improve quality, regulate the growth period and improve the economic efficiency, the optimum

condition of crop growth is obtained on the basis of taking full use of natural resources by changing greenhouse environment factors such as temperature, light, water level. Greenhouse measurement and control system is a complex system， it needs to various parameters in greenhouse automatic monitoring, information processing, real-time control and online optimization through MATLAB. The development of greenhouse measurement and control system has made considerable progress in the developed countries, and reached the multi-factors comprehensive control level, but if we introduce the foreign existing systems, the price is very expensive and maintenance isn't convenient. In recent years, our country have launched many studies in aspects of greenhouse structure and control, and made a lot of achievements, but the greenhouse measurement and control system is mostly based on cable, so it is not onlywiring complex, but also unfavorable to improve thesystem efficiency. With the rapid development of the lowcost, low power sensor and wireless communication technology, the conditions that construct wireless greenhouse measurement and control system becomes mature, and it is important to realize agricultural modernization. According to the needs of quickly and accurately acquisition greenhouse environment information, further studies in aspects of greenhouse environment information collection, treatment, transmission and so on, and we have developed greenhouse measurement and control system based on 8051 microcontroller and wireless sensor networks. This system has high practical value to realize information and automation of large-scale greenhouse monitoring and improve work efficiency.

The general structure of the system

The greenhouse measurement and control system compose of the monitoring center, sensor nodes and control equipments. Sensor nodes are deployed in every place of greenhouse, the responsible for periodic acquisition greenhouse environment information and send it to control center. The control center analyze these data which has been obtained, then relevant decisions are made and send control message to greenhouse control equipment, which regulate greenhouse environment parameters to obtain best growth environment for crops. Modern greenhouse has very large size, and which adopt hierarchical system structure. Supposed that greenhouse is rectangular area, the measurement system overall structure is shown in Fig.1.



In Fig.1, the rectangular greenhouse was divided into several same area of greenhouse, each measurement and control area is managed by a base station, and is divided into many virtual grids which have the same sizes and is non-overlapping. A number of sensor nodes are deployed in virtual grid and make a cluster, each cluster includes a cluster head (sink node) and some cluster member nodes. Cluster head generated from the member nodes through cluster head election algorithm, and cluster member nodes compose of sensor nodes which can collect environmental data and control nodes which can control actuators and adjust environmental parameters. Control node does not participate in cluster head election, it obtain command which the monitoring center send from cluster head node and execute corresponding control operation. The star network composed of Cluster head nodes, sensor nodes and control nodes, it mainly complete data acquisition and control of greenhouse environment. The data which is collected is transmitted directly from sensor nodes to cluster head, the cluster nodes transferred data to the base station by way of multiple hops, at last, the base station transferred each cluster head node data which is packaged to the monitoring center. Base station is relay station between the monitoring center and greenhouse WSN nodes, the network control is realized by managing all the nodes of single greenhouse measurement and control area. The monitoring center is not only total console of more greenhouse network, but also data center of measurement and control system of the greenhouse network , and take charge of control and management of the entire system.

2. HARDWARE USED

AT89c51-ds

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density non-volatile memory technology and is compatible with the industry standard MCS-51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

Port1 is used as input port as all sensors are connected to it. Port0 is output port. LEDs and CPU which are outputs for light sensor and smoke sensor respectively are connected at this port. LCD display is used in this project and the to be displayed on it is given from Port2. To Port3 transceiver, CC2500, is connected for wireless communication with monitoring system. And at pins 18 and 19 crystal oscillator of 12MHz is connected.

VT-CC2500-M1 Wireless Module

VT-CC2500-M1 is based on RF transceiver CC2500 of TI Chipcon, it's a small size and low power consumption module. CC2500 is a low-cost 2.4 GHz transceiver designed for designed for very low power wireless applications. The circuit is intended for the 2400-2483.5MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band. The MAX RF output power can be set as high as +1dBm, with data rate as high as 500Kbps. The module integrated many RF functions thus you can use it conveniently and reducing your development time.

DS18B20

The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with non-volatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. It has an operating temperature range of -55°C to +125°C and is accurate to ±0.5°C over the range of -10°C to +85°C. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply.

3. SOFTWARE USED FOR MONITORING

MATLAB

MATLAB (matrix laboratory) is a computing environment and fourth-generation programming language. MATLAB is used for monitoring in this project. As this software allows plotting of functions and data, so graphs of output can be easily plotted for further references.

4. APPLICATIONS

- The project can be extended to greenhouses where manual supervision is far and few in between.
- The general applications are in Industrial Automation, weather stations, Home automation etc.
- It is also be used for alert system about the changes in the environment.

5. CONCLUSION

According to the characteristics of modern greenhouse production, the paper introduce wireless sensor network technique to greenhouse wireless detection-control system, and the whole greenhouse system can automatic adjust by combining wireless sensor network technology with greenhouse control technology. In hardware, WSN nodes mainly compose of Atmega128L and wireless transceiver chip CC25000. In software, the modularized design ideas is adopted in this paper, the sensor nodes deployment is made a in-depth analysis, the simulation results show that this algorithm can effectively prolong the network life.

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